

Dr Math gets MUDDY: The “Dirt” on How to Attract Teenagers to Mathematics and Science by Using Multi-User Dungeon Games over Mxit on Cell Phones

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Abstract: The current group of teenagers has been called many things – some of the terms unprintable in respectable publications. However terms such as the “thumb tribe” (because they can type faster on their cell phones with their thumbs than adults can type on a keyboard using ten fingers) and “gamers” (because they play computer games for hours, and even days, at a time) are indicative of the close relationship teenagers have with their cell phones and computers. This paper explores a project where multi-user dungeon games (MUDs) with a science and mathematical twist were deployed using Mxit (a popular instant messaging system in South Africa) on cell phones to encourage teenagers to learn more about math and science to practice math and science skills.

Keywords: Dr Math, Mxit, mud, xmpp

1. Introduction

A shocking 93% of first year university students in South Africa do not have sufficient mathematics knowledge to cope with first year university course materials [1]. At the same time, recent research into cell phone usage among teenagers puts South African teenage cell phone usage near 97% [2, 3].

In order to help solve the problem of lack of mathematics skills by taking advantage of the high cell phone usage among teenagers in South Africa, Meraka Institute initiated the “Dr Math” project in January, 2007. “Dr Math” allows teenagers (and younger children) to reach tutors to help them with their mathematics homework using Mxit (a text based chat system) on their cell phone. During the periods of time when tutors are not available, there are single-user text adventure games, multi-user arithmetic competitions, multi-user algebra skills competitions, multiple choice quiz competitions, and static lookups for information such as definitions and formulae [4-6].

During the past 3 years that “Dr Math” has been operational, all of the facilities have been extensively used and have attracted over 6000 participants. There was one major exception, however. The single-user text adventure game has not attracted as many participants as the multi-user competitions. In addition, many of the participants who played the single-user text adventure game, would either not finish the game or would play the game once and not return.

It was suggested there were two reasons that the text adventure game was not popular:

1. The fact that the text adventure game was single-user and that the players could not interact with each other was deemed to be detrimental to the game.
2. The text adventure game was designed and written by an adult computer programmer and it was not designed or written by a teenager or “near-teenager” with gaming experience.

This paper describes a project where students from the University of Pretoria were tasked with designing and writing a multi-user text adventure game (also known as a MUD – Multi User Dungeon) to entice teenagers (and younger children) to enjoy mathematics and science, practice their skills, and show off their knowledge.

2. Meraka Institute and the University of Pretoria

“Dr Math” is just one of many research projects in which Meraka Institute and the University of Pretoria have collaborated and continue to collaborate. Early during the initial stages of the “Dr Math” project, University of Pretoria provided (and continues to provide) the tutors who assist the participants with their mathematics homework. This tutor participation is part of a course which engineering students at the University of Pretoria could take as part of their degree program.

For the creation of this MUD game, Meraka Institute approached lecturers for another course at the University of Pretoria. This was a software engineering course where the students formed “teams” or “companies.” Potential clients, such as Meraka Institute, could submit an RFP (Request for a Proposal). The “teams” or “companies” would compete in submitting actual proposals to the various clients and then continue on to develop the software, test the software, and deliver a completed product to the client.

The game software described in this paper is the product of one of these teams.

3. What is Mxit?

The term “Mxit” is ambiguous. It can refer to three different things. It can refer to a Java midlet which can be downloaded onto your cell phone. It can refer to the service which allows these Java midlets to talk to one another. It can also refer to the South African company which wrote the software and hosts the service.

Mxit is a text based chat facility which runs over cell phones using GPRS (or 3G as the case may be) as a carrier. In South Africa, data packets sent and received over GPRS cost approximately ZAR 2.00 per megabyte. This is approximately US\$0.25 (or an American “quarter”) per megabyte. SMSs, on the other hand, can cost anywhere between twenty South African cents and eighty South African cents depending on contract types.

Mxit takes advantage of the low cost of data packets over GPRS and provides a chat system where participants send and receive text messages at an extremely low cost. This low cost is one of the reasons that teenagers and children use Mxit in vast numbers. According to various press releases released by Mxit LifeStyle (Pty) Ltd., Mxit boasts over 14 million users of their service.

4. What is a MUD?

In the early 1970's, a role-playing game called "Dungeons and Dragons" took the gaming culture by storm. The game required a "Dungeon Master" to create an imaginary world in which players could assume the roles of characters and become part of the story and history of the world. Several years later, a basic form of this concept was incorporated into an early computer game called "Adventure" which allowed players to navigate through a maze that was presented to them through text descriptions on a computer screen. The term "dungeon" persisted, and in the case of a MUD (short for Multi User Dungeon) refers to a virtual social environment [7]. MUDs are text based computer programs that accept network connections from multiple "players" simultaneously and provide a shared environment of "rooms" and "objects" [8]. Players can wander through the "rooms" interacting with the various "objects". Players can also interact with each other if they are in the same "room".

The term MUD is sometimes also used to refer to Massively Multiplayer Online Role Playing Games (MMORPGs) like "The World of Warcraft". MMORPGs essentially provide the same functionality as described above, but they include rich graphical interfaces and world representations that are distinctively lacking, sometimes intentionally, in early MUDs. Throughout this article we use the term MUD to refer to classic, text based Multi User Dungeons.

5. Methodology

The MUD was developed entirely in Java in order for it to interface with the existing software on the Dr Math server. This also means that, although the game was developed for Linux, it is a cross-platform system.

We loosely based the development of the game on the action research methodology [9] by requiring team members from different fields of study to play it after each major modification and provide feedback. This allowed us to improve the system's technical aspects and usability in a parallel fashion.

To ensure that problems in the game are relevant to student's syllabi and on the required standard, we adapted questions from past papers to be relevant to the game story. The initial quests that were deployed are based on Gr 8 and Gr12 syllabi. The next step is to investigate the logs – recorded for security and research purposes under an ethics code, cleared by the Tshwane University of Technology - created from students' game sessions to identify trends in game play and adapt the system to the users' needs.

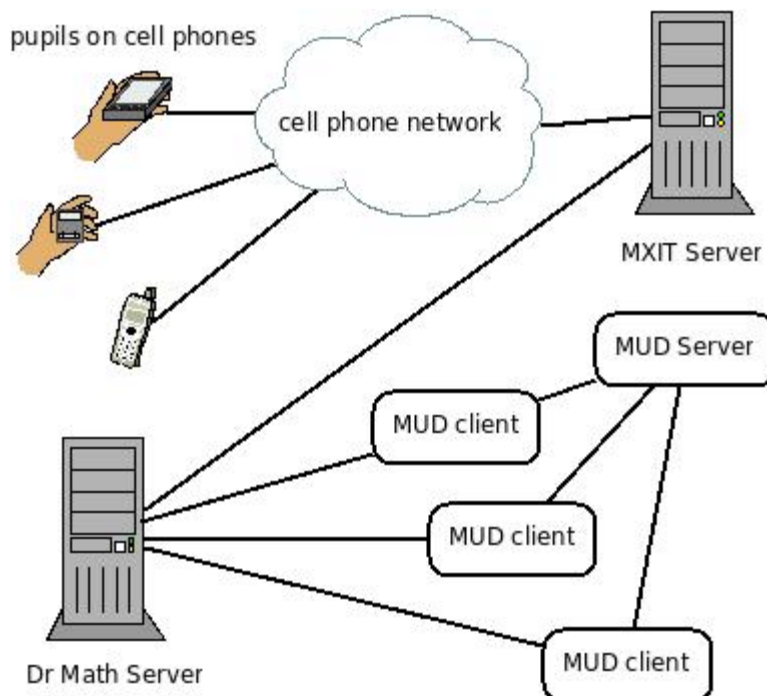
6. Technology Description

In view of the fact that it was participants on their cell phones who were interacting with this MUD, the technologies involved in getting the information from the participants to the MUD and back were numerous.

Information from the pupils on their cell phones would navigate the cell phone network in order to reach the Mxit server. The Mxit server and Dr Math server would communicate allowing the messages to be sent to "Dr Math". Depending on configuration options, "Dr Math" would recognise this information as commands to the MUD game. Every participant in the MUD game would have a copy of the MUD client program running. All MUD clients would communicate to one single MUD server.

This configuration required that each player receive his/her own game thread on the Dr Math server. Each player thread would also receive its own instance of the game interpreter (see section 8). When a player thread receives a line of text from the Dr Math server, it is immediately sent to the thread's interpreter for analysis. The interpreter edits the string so that it is in a format that the game will understand and then passes it to the singleton [10] instance of the MUD server. From here, the input string is tokenized and parsed by the

game's LL(1) parser[11] which determines the semantics of the user input and calls the relevant methods to perform the required actions.



The fact that the server module is a singleton entity means that any changes to the state of the game are immediately effective in all player threads without the need to explicitly update each player's state.

During this project, an additional access channel through Google Talk was also implemented allowing participants chatting via Mxit to “play” against participants chatting via Google Talk.

7. Teacher Defineable “Quests”

In order to address the issue of creating new quests for the MUD, we came up with an XML structure to define quests and items. Each quest has a beginning and ending storyline and at least one room. The creator of a quest specifies descriptions for all the rooms and objects. Each room also has one quest object, which contains the question for the specific room, and various room objects. Each quest object has an action associated with it that needs to be performed in order for the player to access the question. If the player then answers the question correctly, a reward message appears and the player is advanced to the next room. The reward message also acts as a story telling mechanism. The creator of a quest can also specify objects that are usable on the current question. A player can then use these items – assuming the player has such an item in his/her possession – to get clues like formulas that are relevant to the question. Room objects may contain sub-room objects for example if the room object is a cupboard then a sub-room object may be a jacket.

Below are two screenshot of the PHP Quest Creator. The quest creator was designed as a webpage to allow us the option of providing players the ability to create and submit quests in the future.

Even though the primary target of Dr Math is science and mathematics students, the structure of the quests allows for quest from other domains besides math and science to be created. In the screenshot example above, the items and actions are not predefined, meaning that we can create new actions and items in the game simply by typing their names into the quest creator. In other words, a teacher can create a quest which is aimed at teaching kids about HIV/AIDS prevention or history, for example.



EduQuest

quest creator

Name of quest:

Number of rooms:

Room 1

[Show/Hide](#)Room Description: [help?](#)

You are in a forest.

Name of quest object: [help?](#)Quest object description: [help?](#)

The tree is tall and sways in the wind.

Quest object action: [help?](#)Question: [help?](#)If you weigh 70kg and the gravitational pull of the planet is 10m/s², what is the minimum force (in Newton) you need to use to pull yourself up the tree?Answer: [help?](#)Reward text: [help?](#)

You climb the tree and find a bird's nest in one of the branches.

Hint Items: [help?](#)Item name: [help?](#)Clue: [help?](#)

70kg = 700N

Room Items: [help?](#) [help?](#)

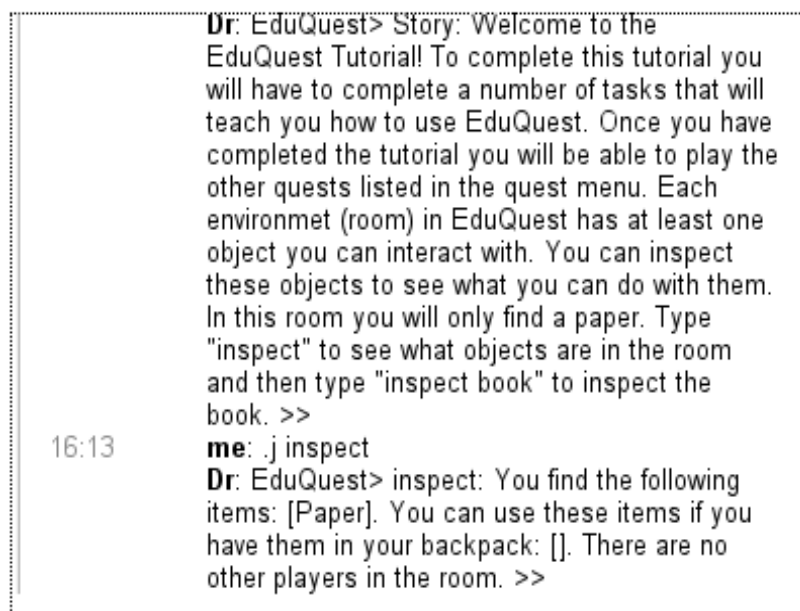
The resulting XML is saved in a folder where the game can find it during run-time. This means there is no need to restart the game server when new quests are added. The XML for our previous example is shown below.

```

<quest>
<beginQuestStoryline>This is a sample quest. </beginQuestStoryline>
<room id="1">
  <roomDescription>You are in a forest.</roomDescription>
  <questObject>
    <name>Tree</name>
    <description>The tree is tall and sways in the wind.</description>
    <action verb="climb"></action>
  </questObject>
  <question>If you weigh 70kg and the gravitational pull of the planet is 10m/s^2, what is
the minimum force (in Newton) you need to use to pull yourself up the tree?</question>
  <answer>700</answer>
  <reward message="You climb the tree and find a bird\'s nest in one of the branches.">
  </reward>
  <useObject>
    <calculator>70kg = 700N</calculator>
  </useObject>
  <roomObjects>
    <roomObj>
      <name>Stone</name>
    </roomObj>
    <roomObj>
      <name>Log</name>
    </roomObj>
  </roomObjects>
</room>
</quest>

```

Below are some screenshots of a game session being played over google talk.



8. Interpreting Mxit “lingo” or slang

Since SMS technologies were introduced in the early 1990's it has revolutionised the world of communication. According to a study in Germany, SMS messaging accounted for about 80% of data revenue generated for Western-European mobile operators in 2005, making it one of the most successful data services in recent years [12]. The widespread usage of SMS, coupled with limitations on the maximum length of SMS messages, has lead to a rather unexpected change in language usage, namely SMS “lingo” or slang.

The use of slang in written form over mediums such as SMS or Mxit is widely seen as detrimental to the education and literacy of students, and has been shown to affect students'

school work. However, some language specialists welcome this behaviour as “a new form of communication ... taking hold in the linguistic sphere” [13].

Whether SMS and Mxit slang is good or bad is a debate beyond the scope of this article, but we thought it to be an important factor in the development of an interactive game that is meant to be played over this medium. There is simply no doubt that students will want to interact with the game in a manner that they are comfortable and familiar with; and the hypothesis is that they will stay engaged for longer periods of time if we are able to provide this functionality.

The EduQuest interpreter is our first attempt at translating SMS slang into meaningful terms that can be correctly parsed and used by the game. It makes use of a simple heuristic function that uses, among others, the length of input strings and the order of the consonants in these strings to dynamically calculate the probability that a given slang term maps to a specific command or object in the player's current environment. This allows players to specify an object such as a calculator by typing something like “calc” or “clc” instead of having to type the entire word. The interpreter can, naturally, also ignore minor spelling mistakes. For instance “hwlp”, “hlp” and “hp” will all be correctly identified as meaning “help”.

Thus, as a side effect, we are catering not only for widely used SMS slang, but also for common spelling mistakes that frequently occur in environments like google talk where a qwerty keyboard is used for typing.

9. Results

The initial MUD with two quests was deployed on the “Dr Math” server in mid-October. In South Africa, the academic year coincides with the calendar year with November being reserved for exams and December for holidays. Initial testing with a small pilot group of teenagers indicated that the MUD game is more “teenager-friendly” than our original single-user text adventure game. During each game session, all communications between the user and Dr Math server were recorded. These logs were then used to evaluate users' habits and playing statistics, and give us an idea of how interesting they found the game.

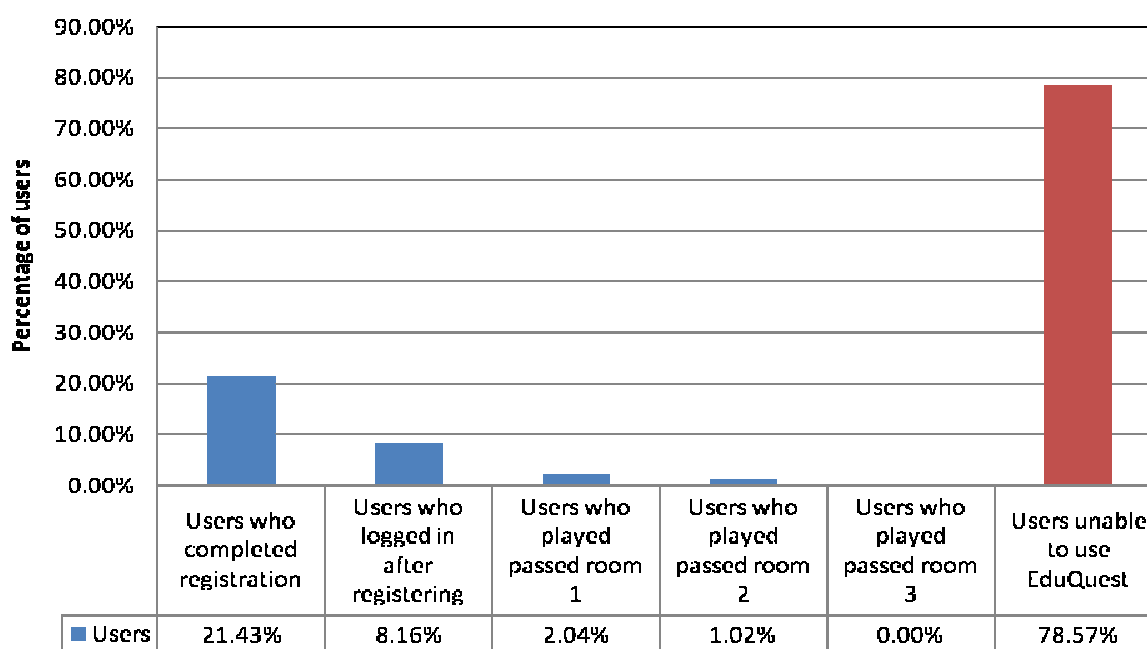
While analyzing the recorded logs it was found that, despite positive indications from the pilot group, a surprising number of users were unable to effectively navigate the text-based user interface. Only about 21 per cent of users who initiated a game session were able to complete the registration. And of those users, less than half were able to log in with their newly created accounts. Furthermore, the number of users who were able to play the game after having logged in could be counted one hand and amounted to just 2 per cent. A staggering 78 per cent of users were unable to use the system at all.

The logs further showed that a large proportion of players who managed to log in successfully would play the game in short bursts of about ten to fifteen minutes at a time. They would then leave the game and come back at a later stage (in some cases after a few days) to continue playing. Interestingly though, no users have yet played the game passed the first few rooms.

Feedback we got from users supported our findings in that many of them complained that it was too difficult to navigate the interface, while others complained that the game was too easy. This could explain why the few users who did manage to log in and play stopped playing after the first few rooms.

The graph below illustrates the results in greater detail.

Measurement of user performance



10. Business Benefits

Hagel and Armstrong [14] explain the rise of virtual communities and how there exists a shift in power from vendors of goods and services to the customers who buy them. This paper also states how people are able to play games on these sites yet they have no communication between other users. EduQuest and MXit allows for users to learn, while playing games, and communicate with other online users.

EduQuest is versatile and can be played over a simple LAN, MXit, Google Talk and even take a step further and deploy a version compatible with Facebook. This would reach a much larger audience. The concept of money making Facebook game applications are evident. The role taken by Zynga, a game development company that is making money off social networking, in their implementation of “Farmville”. Farmville is the fastest growing web-based game on Facebook.

11. Conclusions and Way Forward

The results of this initial attempt at using a MUD to encourage pupils to interact with science and mathematics content will influence the next iteration of this project. It is clear from the results that the security model (the username and password registration model) was too restrictive and effectively discouraged pupils for playing. The few pupils who “came back” to play later leads us to believe that the security model could be thrown away and pupils could just play the game in one session thereby removing the requirement for usernames and passwords on the game. Alternatively, the security model could be modified to allow pupils to play but if they wanted to save the game, they would then have to create a username and password for the saved game.

Meraka Institute's “Dr Math” project will continue to experiment with new and innovative ways to provide teenagers and children with educational mathematics (and, to some extent, science) content using a medium which teenagers and children love – their cell phones. This project to investigate the use of MUD games will continue for another year. It is expected that another “team” or “company” of students from the University of Pretoria providing another MUD game next year.

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